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“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

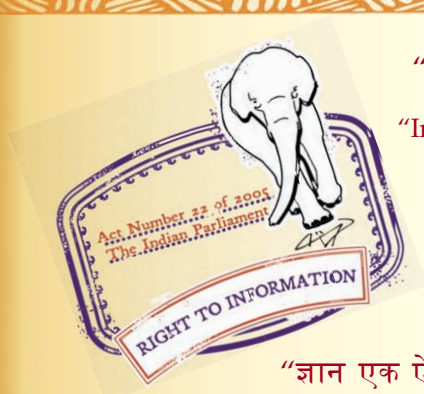
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 9000-3-1 to 5 (1977): Basic Environmental Testing Procedures for Electronic and Electrical Items, Part 3: Dry Heat Test (Sections 1-5) [LITD 1: Environmental Testing Procedure]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS : 9000 (Part III/Sec 1 to 5) - 1977
(Reaffirmed 2004)

Indian Standard

BASIC ENVIRONMENTAL TESTING
PROCEDURES FOR ELECTRONIC AND
ELECTRICAL ITEMS

PART III DRY HEAT TEST

(Third Reprint SEPTEMBER 1992)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

0. FOREWORD

0.1 This Indian Standard (Part III) was adopted by the Indian Standards Institution on 1 September 1977, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The differences in environmental testing procedures for component type items and equipment type items are fast disappearing in the context of technological developments. It is, therefore, found necessary to have uniform testing procedures wherever possible. This series of standards on environmental testing procedures (IS : 9000) has been prepared with this objective. This is also in line with the principle adopted by IEC/TC 50 Environmental Testing in developing unified series of standards on environmental testing procedures by International Electrotechnical Commission.

0.2.1 It is proposed to withdraw the existing Indian Standards, namely, IS : 589-1961* and IS : 2106† series dealing with environmental tests for electronic components and equipment respectively, as soon as the tests mentioned therein are covered in the new series (IS : 9000).

0.3 This standard deals with dry heat tests applicable both to heat dissipating and non-heat dissipating items.

0.4 The object of the dry heat test is limited to the determination of the ability of components, equipment or other articles to be used or stored at high temperature. These dry heat tests do not enable the ability of items to withstand or operate during temperature variations to be assessed. In

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

†Environmental testing procedures for electronic and electrical equipment.

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this case, it would be necessary to use 'change of temperature test' [see IS : 9000 (Part XIV)-1977]*.

0.5 This standard is based on IEC Publication 68-2-2 (1974) 'Basic environmental testing procedures, Part 2: Tests, Tests B: Dry heat', issued by the International Electrotechnical Commission.

0.6 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS :2-1960†.

*Basic environmental testing procedures for electronic and electrical items:
Part XIV Change of temperature.

†Rules for rounding off numerical values (*revised*).

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

Section 1 General

1. SCOPE

1.1 This standard (Part III/Sec1) gives general information on dry heat tests applicable both to non-heat dissipating and heat dissipating items.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms given in IS: 9000 (Part I)-1977* shall apply.

3. CLASSIFICATION OF DRY HEAT TESTS

3.1 The dry heat tests are classified as follows (see also Table 1):

- a) Dry heat tests for non-heat dissipating items:
 - i) with sudden change of temperature (see Section 2);
 - ii) with gradual change of temperature (see Section 3).
- b) Dry heat tests for heat dissipating items:
 - i) with sudden change of temperature (see Section 4);
 - ii) with gradual change of temperature (see Section 5).

4. APPLICATION OF DRY HEAT TESTS

4.1 General — The procedures given in this standard are normally intended for items which achieve temperature stability during the performance of the test procedure. The duration of the test commences at the time when temperature stability of the item has been reached. For the exceptional cases when the item does not reach temperature stability during the performance of the test procedure, the duration of the test commences at the time when the test chamber reaches the test temperature.

*Basic environmental testing procedures for electronic and electrical items:
Part I General.

TABLE 1 CLASSIFICATION OF DRY HEAT TESTS

(Clause 3.1)

SUFFIX LETTER (see 7 and Fig. 1 and 2)	ITEM TYPE	TEMPERATURE CHANGE	ITEM TEMPERATURE AT COMMENCEMENT OF TEST DURATION
(1)	(2)	(3)	(4)
a	Non-heat dissipating	Sudden	Stabilized (see Note)
b	Non-heat dissipating	Gradual	Stabilized (see Note)
c	Heat dissipating	Sudden	Stabilized (see Note)
d	Heat dissipating	Gradual	Stabilized (see Note)

NOTE -The items will normally reach temperature stability before commencement of test duration. In exceptional cases, this will not be so, and additional information may be required to be specified in the relevant individual standard.

4.1.1 The relevant specification shall define:

- a) the rate of change of temperature in the test chamber;
- b) the time at which the items are introduced into the test chamber;
- c) the time at which the exposure commences; and
- d) the time at which the items are energized.

NOTE — Guidance on choosing the four parameters mentioned in 4.1.1 are given in IS : 9001 (Part II)-1977*.

4.2 For Heat Dissipating Items — An item is considered heat dissipating only if the hottest point on its surface, measured in free air conditions (that is, with no forced air circulation), is more than 5°C above the ambient temperature of the surrounding atmosphere after temperature stability has been reached [see IS : 9000 (Part I)-1977†]. In such cases, the dry heat tests specified in Section 5 shall apply.

4.2.1 For such items, when the relevant specification calls for a storage test or does not specify an applied load during the test, the dry heat tests specified in Sections 4 and 5 shall apply.

4.3 For Non-heat Dissipating Items

4.3.1 In dry heat test for non-heat dissipating items with sudden change of temperature (see Section 2), the item is introduced into the test chamber, the latter being at the temperature specified for the test. It has been introduced as a convenient and time-saving method. This test shall be used only when it is known that the effects of a sudden change of temperature are not determined to the test item.

*Guidance for environmental testing: Part II Cold and dry heat tests.

†Basic environmental testing procedures for electronic and electrical items: Part I General.

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4.3.2 In dry heat test for non-heat dissipating with gradual change of temperature (see Section 3), the item is introduced into the test chamber, the latter being at the laboratory temperature. The temperature in the chamber is then increased gradually so as to cause no detrimental effects on the test item due to the temperature change.

5. GUIDANCE ON DRY HEAT TESTS

5.1 The guidance details for the different types of dry heat tests are given in IS : 9001 (Part II)-1977* which is a necessary adjunct to this standard.

6. TESTING OF HEAT DISSIPATING ITEMS WITH AND WITHOUT FORCED AIR CIRCULATION

6.1 The preferable method of testing heat dissipating items is that which does not use forced air circulation.

6.2 If this is impracticable, dry heat tests with forced air circulation, the details of which are covered in Sections 4 and 5, may be applied.

6.2.1 Two methods for testing with air circulation are given (Method A and Method B). Method A applies to the cases where the chamber is large enough to comply with the requirements for testing without forced air circulation, but where the high temperature cannot be maintained without circulating the air in the chamber. Method B applies to the cases where the chamber is too small to comply with the requirements for testing without forced air circulation.

7. DIAGRAMMATIC REPRESENTATIONS

7.1 To facilitate the choice of test method, a diagrammatic representation of the various procedures is given in Fig. 1. Several clauses are identical, especially in Sections 2 and 3, and in Sections 4 and 5. A block diagram showing which clauses are identical and which are different is given in Fig. 2.

*Guidance for environmental testing: Part II Cold and dry heat tests,

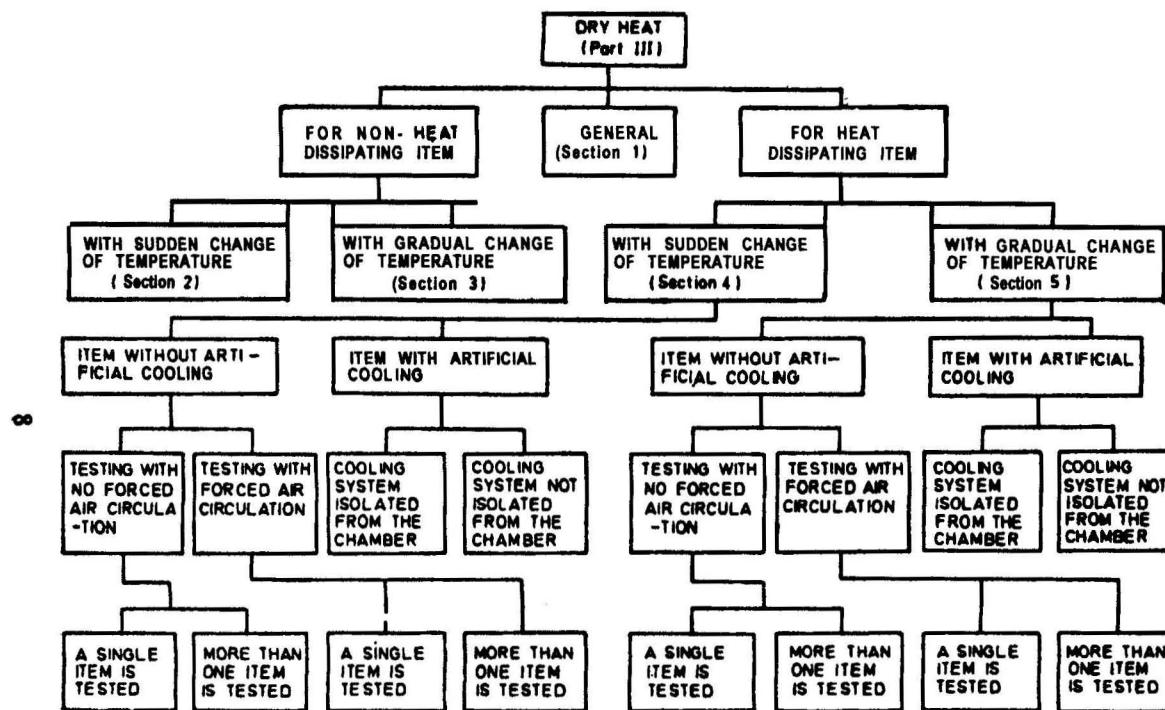
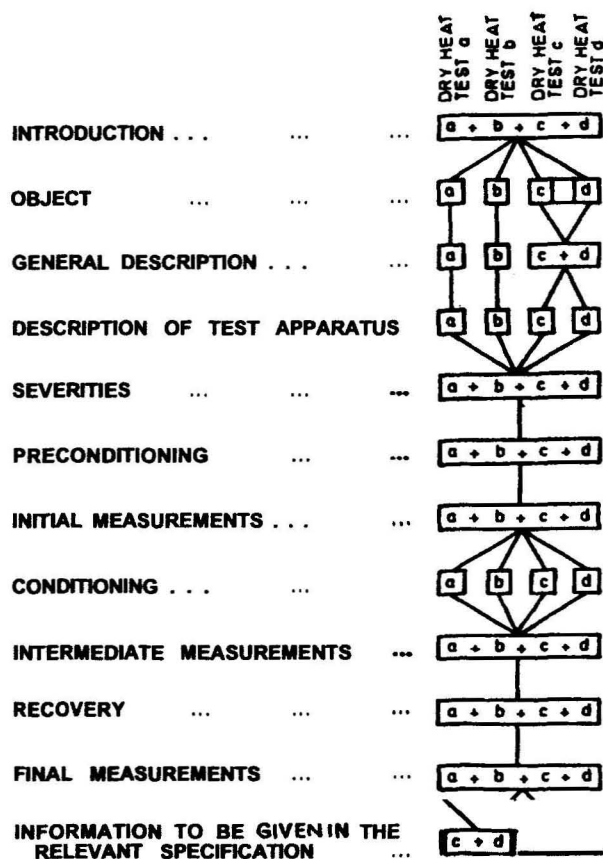


FIG. 1 DIAGRAMMATIC REPRESENTATION OF THE VARIOUS TEST PROCEDURES



NOTE — Dry Heat Test a — Dry heat test for non-heat dissipating item with sudden change of temperature.
 Dry Heat Test b — Dry heat test for non-heat dissipating item with gradual change of temperature.
 Dry Heat Test c — Dry heat test for heat dissipating item with sudden change of temperature.
 Dry Heat Test d — Dry heat test for heat dissipating item with gradual change of temperature.

FIG. 2 IDENTICAL AND DIFFERENT CLAUSES OF THE DIFFERENT DRY HEAT TESTS a, b, c AND d

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

Section 2 Dry Heat test for Non-heat Dissipating Items with Sudden Change of Temperature

1. SCOPE

1.1 This standard (Part III/Sec 2) deals with dry heat test for non-heat dissipating items with sudden change of temperature.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms given in IS : 9000 (Part I)-1977* shall apply.

3. OBJECT

3.1 The object of this standard is to provide test procedure to determine the suitability of non-heat dissipating items for use and/or storage under conditions of high temperature and for which the subjection to a sudden change of temperature has no detrimental effects.

3.1.1 This procedure is for items which are subjected to an elevated temperature for a time long enough for the item to achieve temperature stability.

3.1.2 In this procedure, the test duration is normally measured from the time when the item achieves temperature stability. For cases where this does not apply, see 4.1 of Section 1.

4. GENERAL DESCRIPTION

4.1 In this test, the item while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature appropriate to the degree of severity as specified in the relevant specification. After temperature stability of the test item has been reached, the

*Basic environmental testing procedures for electronic and electrical items: Part I General.

item is exposed to these conditions for the specified duration. Items under test are normally in non-operating conditions.

4.2 Forced air circulation is normally used for this test.

5. DESCRIPTION OF TEST APPARATUS

5.1 The chamber shall conform to relevant provisions of IS : 9002 (Part II)-1977* as applicable for carrying out dry heat test on non-heat dissipating items with sudden change of temperature. The significant requirements are briefly described in 5.1.1, 5.1.2 and 5.1.3.

5.1.1 The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in 6.1(a). Forced air circulation may be used to maintain homogeneous conditions.

5.1.2 In order to limit radiation problems, the temperature of the walls of the chamber shall not differ by more than 3 percent of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls and the items shall be unable to 'see' any heating or cooling elements which do not comply with this requirement.

5.1.3 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 percent relative humidity at 35°C). When testing is performed at a temperature lower than 35°C, the relative humidity shall not exceed 50 percent.

6. SEVERITIES

6.1 The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given below:

a) Temperature:

- + 200 \pm 2°C
- + 175 \pm 2°C
- + 155 \pm 2°C
- + 125 \pm 2°C
- + 100 \pm 2°C
- + 85 \pm 2°C
- + 70 \pm 2°C
- + 55 \pm 2°C
- + 40 \pm 2°C

*Specification for equipment for environmental tests for electronic and electrical items; Part II Chamber for dry heat test.

IS : 9000 (Part III/Sec 2) - 1977

NOTE 1 —The severity of $30 \pm 2^\circ\text{C}$ is not considered as a dry heat severity for India. However, some equipment (for example, equipment installed in an air-conditioned atmosphere) may require conditioning and testing at a temperature lower than $+ 40^\circ\text{C}$ and in such a case a severity of $+ 30^\circ\text{C}$ should be chosen by the relevant specification.

NOTE 2 — In the absence of other considerations, temperatures above 200°C and up to 1000°C should be chosen from the following values:

250°C, 315°C, 400°C, 500°C, 630°C, 800°C and 1000°C.

The tolerance in each case should be ± 2 percent of the above temperatures in $^\circ\text{C}$.

NOTE 3 —Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to $\pm 3^\circ\text{C}$ up to 100°C and $\pm 5^\circ\text{C}$ up to 200°C . When this is done, the tolerance used shall be specified in the test report.

b) Duration:

2 hours
4 hours
16 hours
72 hours
96 hours

6.2 Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of relevant standards which give particular requirements for durations for such tests.

6.3 If the only intention of the testing procedure is to show whether the item will function at high temperature, the conditioning may be limited to a time such that the item under test has reached temperature stability. In no case shall the duration be less than 30 minutes.

7. PRECONDITIONING

7.1 The relevant specification may call for a preconditioning.

8. INITIAL MEASUREMENTS

8.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

9. CONDITIONING

9.1 The chamber shall be at the temperature of the specified severity. The item, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, 'ready for use' state, in its normal position, or as otherwise specified.

9.1.1 When the test item is intended for use with specific mounting devices, these should be used for testing.

IS : 9000 (Part III/Sec 2) - 1977

9.1.2 The test (ambient) temperature shall be measured as in 2.1 of IS : 9000 (Part I)-1977*.

9.2 Time shall then be allowed for the chamber conditions to be re-established and for the item to reach temperature stability.

9.3 If required by the relevant specification, the item shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification,

9.3.1 If required by the relevant specification, the item shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification, or be switched off.

NOTE— An item, even under operating or loaded conditions shall be considered as non-heat dissipating as long as its surface temperature rise is not more than 5°C above the ambient temperature.

9.4 The item shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

9.4.1 The duration shall be measured from the time when temperature stability has been reached.

NOTE— In the case of small items, it is not necessary to check by measurement that temperature stability has been reached [see Note 2 under 2.3 of IS : 9000 (Part I)-1977*].

9.5 If required by the relevant specification, intermediate measurements shall be performed in accordance with 10.

9.6 At the end of this period, the item shall be subjected to the recovery procedure. In case the item remains in operating or loaded conditions during the test, it shall be switched off or unloaded before being subjected to the recovery procedure.

10. INTERMEDIATE MEASUREMENTS

10.1 The relevant specification may call for loading and/or measurements during or at the end of the conditioning while the item is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the item shall not be removed from the chamber.

*Basic environmental testing procedures for electronic and electrical items: Part I General.

IS : 9000 (Pad III/Sec 2) - 1931

NOTE — Measurements preceded by recovery, which would require removal and reintroduction of the items into the chamber, are not permissible during the conditioning.

If it is desired to know the performance of the types of item before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

11. RECOVERY

11.1 The item shall remain under recovery conditions for a period adequate for the attainment of temperature stability, with a minimum of one hour.

11.1.1 When several items are tested simultaneously and where the one hour recovery period is adequate for a single item, the maximum period for recovery shall be two hours and all measurements shall be completed at the end of this period.

11.2 If required by the relevant specification, the item shall be switched on or loaded and measured continuously during the recovery period.

11.3 If the standard recovery conditions given are not appropriate for the item to be tested, the relevant specification may call for other recovery conditions.

12. FINAL MEASUREMENTS

12.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

13. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

13.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

- a) Preconditioning;
- b) Initial measurements;
- c) State of item during conditioning;
- d) Severity (temperature and duration of exposure);
- e) Intermediate measurements;
- f) Recovery, if non-standard;
- g) Final measurement; and
- h) Any deviation in procedure as agreed upon between the purchaser and the manufacturer.

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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

Section 3 Dry Heat Test for Non-heat Dissipating Items with Gradual Change of Temperature

1. SCOPE

1.1 This standard (Part III/Sec 3) deals with dry heat test for non-heat dissipating items with gradual change of temperature.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms given in IS: 9000 (Part I)-1977* shall apply.

3. OBJECT

3.1 The object of this standard is to provide a test procedure to determine the suitability of non-heat dissipating items for use and/or storage under conditions of high temperature.

3.1.1 This procedure is for items which are subjected to an elevated temperature for a time long enough for the item to achieve temperature stability.

3.1.2 In this procedure, the test duration is normally measured from the time when the item achieves temperature stability, For cases where this does not apply, see 4.1 of Section 1.

4. GENERAL DESCRIPTION

4.1 In this test, the item while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature of the laboratory. The temperature is then gradually raised to the temperature appropriate to the degree of severity as specified in the relevant specification. After temperature stability of the test item has been

*Basic environmental testing procedures for electronic and electrical items ; Part I General.

IS : 9000 (Part III/Sec 3) - 1977

reached, the item is exposed to these conditions for the specified duration. Items under test are normally in non-operating conditions.

4.2 Forced air circulation is normally used for this test.

5. DESCRIPTION OF TEST APPARATUS

5.1 The chamber shall conform to the relevant provisions of IS : 9002 (Part II)-1977* as applicable for carrying out dry heat test on non-heat dissipating items with gradual change of temperature. The significant requirements are briefly described in 5.1.1, 5.1.2 and 5.1.3.

5.1.1 The chamber shall be capable of maintaining the specified temperature in the working space within the tolerances given in 6.1 (a). Forced air circulation may be used to maintain homogeneous conditions.

5.1.2 In order to limit radiation problems, the temperature of the walls of the chamber, after temperature stability has been reached, shall not differ by more than 3 percent of the specified ambient temperature of the test, expressed in K. This requirement applies to all parts of the chamber walls and the items shall be unable to 'see' any heating or cooling elements which do not comply with this requirement.

5.1.3 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 percent relative humidity at 35°C). When testing is performed at a temperature lower than 35°C, the relative humidity shall not exceed 50 percent.

6. SEVERITIES

6.1 The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given below:

a) Temperature:

- + 200 \pm 2°C
- + 175 \pm 2°C
- + 155 \pm 2°C
- + 125 \pm 2°C
- + 100 \pm 2°C
- + 85 \pm 2°C
- + 70 \pm 2°C
- + 55 \pm 2°C
- + 40 \pm 2°C

*Specification for equipment for environmental tests for electronic and electrical items : Part II Chamber for dry heat test.

IS : 9000 (Part III/Sec 3) - 1977

NOTE -The severity of $30 \pm 2^{\circ}\text{C}$ is not considered as a dry heat severity for India. However, some equipment (for example, equipment installed in an air-conditioned atmosphere) may require conditioning and testing at a temperature lower than $+40^{\circ}\text{C}$ and in such a case a severity of $+30^{\circ}\text{C}$ should be chosen by the relevant specification.

NOTE 2 — In the absence of other considerations, temperatures above 200°C and up to $1\,000^{\circ}\text{C}$ should be chosen from the following values :

250°C, 315°C, 400°C, 500°C, 630°C, 800°C and 1 000°C.

The tolerance in each case should be ± 2 percent of the above temperatures in °C.

NOTE 3 -Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to $\pm 3^{\circ}\text{C}$ up to 100°C and $\pm 5^{\circ}\text{C}$ up to 200°C . When this is done, the tolerance used shall be specified in the test report.

b) Duration :

2 hours

4 hours

16 hours

72 hours

96 hours

6.2 Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of relevant standards which give particular requirements for duration for such tests.

6.3 If the only intention of the testing procedure is to show whether the item will function at high temperature, the conditioning may be limited to a time such that the item under test has reached temperature stability. In no case shall the duration be less than 30 minutes.

7. PRECONDITIONING

7.1 The relevant specification may call for a preconditioning.

8. INITIAL MEASUREMENTS

8.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

9. CONDITIONING

9.1 The chamber shall be at the temperature of the laboratory.

9.1.1 The item, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, 'ready for use' state, in its normal position or as otherwise specified.

9.1.2 When the test item is intended for use with specific mounting devices, these should be used for testing.

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9.2 The temperature within the chamber shall then be gradually raised to the temperature appropriate to the **degree** of severity and time shall be allowed for the item to reach, temperature stability.

9.2.1 The rate of change of temperature within the chamber shall not exceed 1°C per minute, averaged over a period of not more than 5 minutes.

9.2.2 The test (ambient) temperature shall be measured as in 2.1 of IS : 9000 (Part I)-1977*.

9.3 If required by the relevant specification, the item shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

9.3.1 If required by the relevant specification, the item shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification, or be switched off.

NOTE — An item, even under operating or loaded conditions shall be considered as non-heat dissipating as long as its surface temperature rise is not more than 5°C above the ambient temperature.

9.4 The item shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

9.4.1 The duration shall be measured from the time when temperature stability has been reached.

NOTE — In the case of small items, it is not necessary to check by measurement that temperature stability has been reached [see Note 2 under 2.3 of IS : 9000 (Part I)-1977*].

9.5 If required by the relevant specification, intermediate measurements shall be performed in accordance with 10.

9.6 At the end of this period, the item shall remain in the chamber and the temperature shall be gradually lowered to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of temperature within the chamber shall not exceed 1°C per minute, averaged over a period of not more than 5 minutes.

9.6.1 In case the item remains in operating or loaded conditions during the test, it should be switched off or unloaded before the temperature is lowered.

*Basic environmental testing procedures for electronic and electrical items: Part I General.

IS : 9000 (Part III/Sec 3) - 1977

9.6.2 At the end of this period, the item shall be subjected to the recovery procedure in the chamber or otherwise as appropriate.

10. INTERMEDIATE MEASUREMENTS

10.1 The relevant specification may call for loading and/or measurements during or at the end of conditioning while the item is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the item shall not be removed from the chamber.

NOTE — Measurements preceded by recovery, which would require removal and reintroduction of the items into the chamber, are not permissible during the conditioning.

If it is desired to know the performance of the types of item before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

11. RECOVERY

11.1 The item shall then remain under standard recovery conditions for a period adequate for the attainment of temperature stability, with a minimum of one hour.

11.1.1 When several items are tested simultaneously and where the one hour recovery period is adequate for a single item, the maximum period for recovery shall be two hours and all measurements shall be completed at the end of this period.

11.2 If required by the relevant specification, the item shall be switched on or loaded and measured continuously during the recovery period.

11.3 If the standard recovery conditions given are not appropriate for the item to be tested, the relevant specification may call for other recovery conditions.

12. FINAL MEASUREMENTS

12.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

IS: 9000 (Part III/Sec 3) - 1977

13. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

13.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

- a) Preconditioning;
- b) Initial measurements;
- c) State of item during conditioning;
- d) Severity (temperature and duration of exposure);
- e) Intermediate measurements;
- f) Recovery, if non-standard;
- g) Final measurements; and
- h) Any deviation in procedure as agreed upon between the purchaser and the manufacturer.

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

Section 4 Dry Heat Test for Heat Dissipating Items with Sudden Change of Temperature

1. SCOPE

1.1 This standard (Part III/Sec 4) deals with dry heat test for heat dissipating items with sudden change of temperature.

2. TERMINOLOGY

2.1 For the purpose of 'this standard, the definitions and explanation of terms given in IS : 9000 (Part I)-1977* shall apply.

3. OBJECT

3.1 The object of this standard is to provide a test procedure to determine the suitability of heat dissipating item for use under conditions of high temperature and for which the subjection to a sudden change of temperature has no detrimental effect.

3.1.1 This procedure is for items which are subjected to an elevated temperature for a time long enough for the item to achieve temperature stability.

3.1.2 In this procedure, the test duration is normally measured from the time when the item achieves temperature stability. For cases where this does not apply, see 4.1 of Section 1.

4. GENERAL DESCRIPTION

4.1 In this test, the item while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature appropriate to the degree of severity as specified in the relevant specification. After temperature stability of the test item has been reached,

*Basic environmental testing procedures for electronic and electrical items: Part I General,

IS : 9000 (Part III/Sec 4) - 1977

the item is exposed to those conditions for the specified duration. The relevant specification shall define the functioning of the item under test.

4.1.1 Care shall be taken that any cooling devices of the items are in accordance with that prescribed in the relevant specification.

4.2 The test conditions are designed to simulate the effects of subjecting the test items to 'free air' conditions with defined thermal conduction characteristics of the mounting.

4.3 The specified test temperature is defined as the ambient temperature.

4.4 Testing with no forced air circulation is the preferred method. Forced air circulation may, however, be used when it is difficult, or impossible to meet the conditions specified for testing without air circulation.

5. DESCRIPTION OF TEST APPARATUS

5.1 Testing Chamber -The chamber shall conform to relevant provisions of IS : 9002 (Part II)-1977* as applicable for carrying out on heat dissipating items with sudden change of temperature. The significant requirements are briefly described in 5.1.1 to 5.1.6.

5.1.1 The temperature in the chamber shall be checked by temperature sensing devices located so as to comply with the requirements of 2.1.2 of IS : 9000 (Part I)-1977†.

5.1.2 In the case of testing with no forced air circulation, the chamber shall be large enough compared with the size and amount of heat dissipation of the test item to allow a simulation of the effects of 'free air' conditions. The requirements on the size of chamber in which the effects of 'free-air' conditions are simulated are given in Appendix A as a function of size and heat dissipation per surface unit of the test item.

5.1.3 The walls of the chamber shall be near to thermal black and shall have an emissivity coefficient of not less than 0.7. In order to limit radiation problems, the temperature of the walls of the chamber shall not differ by more than 3 percent of the specified ambient temperature for the test, expressed in K.

This requirement applies to all parts of the chamber walls and the items shall be unable to 'see' any heating or cooling elements which do not comply with this requirement.

5.1.4 In the case of testing in a chamber with forced air circulation, the velocity of the air should be as low as possible.

*Specification for equipment and environmental tests for electronic and electrical items : Part II Chamber for dry heat test.

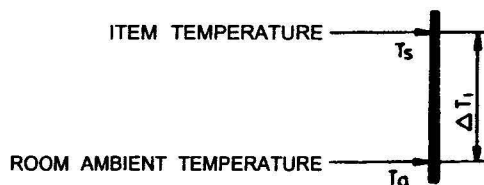
†Basic environmental testing procedures for electronic and electrical items ; Part I General.

5.1.5 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 percent relative humidity at 35°C). When testing is performed at a temperature lower than 35°C, the relative humidity shall not exceed 50 percent.

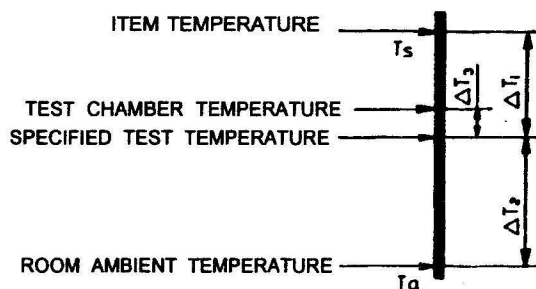
5.1.6 Where a duty cycle is specified, precautions have to be taken, if the test temperature is to be maintained at a steady figure.

In the case of components, a staggering of the on-periods will usually suffice, provided that at any one time the distribution of components on-load is reasonably uniform throughout the test chamber.

Where there is a duty cycle specified for items under test, then during the off-load periods the temperature of the chamber shall not fall below the specified test temperature (see Fig. 1).



Stage 1—Item loaded. Test in laboratory conditions with no forced air circulation, Measurement of item temperature.



Stage 2—Item loaded. Test in chamber with forced air circulation. Monitoring on item temperature. [ΔT_3 shall be small. Measurement of the test chamber temperature is carried out in accordance with 2.1 of IS : 9000 (Part I)-1977 Basic environmental testing procedures for electronic and electrical items: Part I General.]

FIG. 1 DIAGRAMMATIC REPRESENTATION OF TEST WITH FORCED AIR CIRCULATION

5.2 Mounting

5.2.1 The thermal conduction and other relevant characteristics of the mounting and connections of the test item shall be specified in the relevant specification. When the test item is intended for use with specific mounting devices, these shall be used for testing.

5.2.2 Where the item is designed for mounting on a heat sink with unspecified characteristics, the heat sink used for the purpose of test shall possess thermal capacity and thermal conduction adequate to maintain its temperature close to the test chamber temperature,

5.2.3 Where nothing is known about the mounting characteristics, the thermal conduction of the mounting shall be low, such that for all practical purposes the item is thermally isolated.

5.2.4 In the case of component type items, it may be necessary to use mounting racks, in which case the individual specification shall give all details necessary to define the thermal characteristics of the mounting and connections. In particular, where appropriate, specification shall give the length of leads.

5.2.5 When more than one item is tested in the chamber, care shall be taken to ensure that an item is not unduly disturbed by the presence of surrounding items and mounting devices.

6. SEVERITIES

6.1 The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected from those given below:

a) Temperature:

+ 200 \pm 2°C
+ 175 \pm 2°C
+ 155 \pm 2°C
+ 125 \pm 2°C
+ 100 \pm 2°C
+ 85 \pm 2°C
+ 70 \pm 2°C
+ 55 \pm 2°C
+ 40 \pm 2°C

NOTE 1 -The severity of 30 \pm 2°C is not considered as a dry heat severity for India. However, some equipment (for example equipment Installed in an air-conditioned atmosphere) may require conditioning and testing at a temperature lower than + 40°C and in such a case a severity of + 30°C should be chosen by the relevant specification.

NOTE 2 — In the absence of other considerations, temperatures above 200°C and up to 1 000°C should be chosen from the following values:

250°C, 315°C, 400°C, 500°C, 630°C, 800°C and 1 000°C.

The tolerance in each case should be ± 2 percent of the above temperature in °C.

NOTE 3 -Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to $\pm 3^\circ\text{C}$ up to 100°C and $\pm 5^\circ\text{C}$ up to 200°C. When this is done, the tolerance used shall be specified in the test report.

b) Duration:

- 2 hours
- 4 hours
- 16 hours
- 72 hours
- 96 hours

6.2 Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of relevant standards which give particular requirements for durations for such tests.

6.3 If the only intention of the testing procedure is to show whether the item will function at high temperature, the conditioning may be limited to a time such that the item under test has reached temperature stability. In no case shall the duration be less than 30 minutes.

7. PRECONDITIONING

7.1 The relevant specification may call for a **preconditioning**.

8. INITIAL MEASUREMENTS

8.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

9. CONDITIONING

9.1 Item Without Artificial Cooling

9.1.1 *Testing with No Forced Air Circulation*

9.1.1.1 When a single item is tested in the chamber:

- a) The chamber shall be at the temperature of the specified severity.
- b) The item, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, 'ready for use' state, in its normal position or as otherwise specified.
- c) Time shall then be allowed for the chamber conditions to be re-established and for the item to reach temperature stability.

IS : 9000 (Part III/Sec 4) - 1977

- d) The item shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification. The item shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification.
- e) The item shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification. The duration shall be measured from the time when temperature stability has been reached.

NOTE — In the case of small items, it is not necessary to check by measurement that temperature stability has been reached [see Note 2 under 2.1.2 of IS : 9000 (Part I)-1977*].

- f) If required by the relevant specification, intermediate measurements shall be performed in accordance with 10.
- g) At the end of this period, the item shall be subjected to the recovery procedure. In case the item remains in operating or loaded conditions during the test, it shall be switched off or unloaded before being subjected to the recovery procedure.

9.1.1.2 *When more than one item is tested in the chamber* — When more than one item is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test items shall deviate from one item to another by more than 5 deg C or 5 percent of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 — A check that this requirement is met shall normally be made with the items mounted in the chamber in the manner used for testing.

If it is impracticable to make this check inside the chamber, the check may be made outside the chamber under normal laboratory conditions. The items shall be mounted in the manner used for testing (for example, on a rack) and care shall be taken that the items are not subjected to extraneous disturbing influences.

NOTE 2 -The requirement on acceptable deviation between surface temperatures at corresponding points on the test items is intended to limit the effects of stacking of items on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 percent, whichever is the greater) shall not include the deviations caused by differences in heat dissipation between individual items. Such differences can be taken care of by checking on the same individual item in different positions in the chamber.

Testing shall proceed in accordance with 9.1.1.1.

*Basic environmental testing procedures for electronic and electrical items : Part I General,

9.1.2 Testing with Forced Air Circulation

9.1.2.1 When a single item is tested in the chamber-The following method, where forced air circulation is allowed, may be used when it is difficult to meet the conditions specified for testing without air circulation:

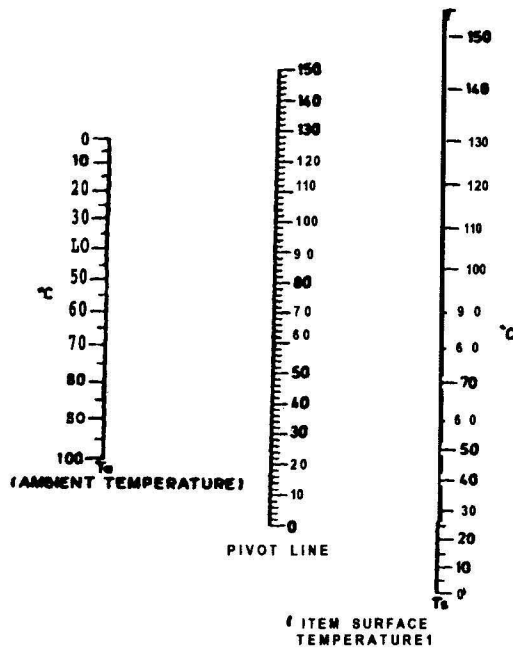
- a) The air velocity shall be low (if possible, not more than 0.5 m/s).
- b) The item suitably mounted in the laboratory and protected from disturbing influences, such as sunlight and draughts, shall be subjected at room ambient temperature to the loading conditions specified for the elevated temperature at which the test is to be carried out. When temperature stability has been reached, the temperature of the hottest point or, in the case of larger or more complicated items, the temperature of a number of representative points shall be measured.. The temperature rise, ΔT_1 , which occurs at each point, shall be noted.
- c) If T_1 is less than 25 deg C, testing shall proceed in accordance with 9.1.1.
- d) If ΔT_1 is greater than 25 deg C, the corrected temperature T_s based on the specified test temperature, shall be determined as described in Fig. 2. The item shall be introduced into the chamber when the latter is at the temperature of the specified severity. The item shall then be switched on or electrically loaded as prescribed in the relevant specification and the temperature of the chamber shall be adjusted to value at which the point measured on the surface of the item at room ambient temperature reaches the above-mentioned stabilized value T_s .
This temperature shall be maintained throughout the conditioning.
- e) Testing shall then proceed in accordance with 9.1.1.1(d) to 9.1.1.1 (g).

A diagrammatic representation is given in Fig. 2. This method is based on the assumption that the difference, ΔT_1 , between the temperature of a hot point on the test item and the ambient temperature of the surrounding air in free air conditions is more or less independent of the ambient temperature of the surrounding air. This applies only if ΔT_1 is less than 25 deg C and where the ambient temperature variation ΔT_2 does not exceed 30 deg C.

These ranges can be extended to 80 deg C and 65 deg C respectively, if the corrections described in Fig. 2 are applied.

It should be noted that the corrections cover convection errors as well as radiation errors.

For temperature differences, ΔT_1 , greater than 80 deg C and/or changes in ambient temperature ΔT_2 , greater than 65 deg C, the validity of this method has not been verified.



Example:

Question: An object dissipating a certain power in free air of 27°C reaches a surface temperature of 70°C .

What will be its surface temperature when dissipating the same power in free air at $+55^{\circ}\text{C}$?

Answer: Draw a straight line from point $+27^{\circ}\text{C}$ on scale T_a to point $+70^{\circ}\text{C}$ on scale T_s ; note its intersection with the pivot line,

Now draw a straight line from point $+55^{\circ}\text{C}$ on scale T_a through this intersection point on the pivot line and read the new intersection with scale T_s ($+98^{\circ}\text{C}$). This is the required surface temperature.

FIG. 1 NOMOGRAM FOR CORRECTION FOR AMBIENT TEMPERATURE

9.1.2.2 When more than one item is tested in the chamber-When more than one item is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test items shall not deviate from one item to another by more than 5 deg C or 5 percent of

the difference between the surface temperature and the-air (ambient) temperature whichever is the greater (see Note 2)

NOTE 1 -A check that this requirement is met shall normally be made with the items mounted in the chamber in the manner used for testing, with the chamber heater switched off but the air circulation switched on.

NOTE 2 -The requirement on acceptable deviation between surface temperature at corresponding points on test items is intended to limit the effects of stacking of items on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 percent, whichever is greater) shall not include the deviations caused by differences in heat dissipation between individual items. Such differences can be taken care of by checking on the same individual item in different positions in the chamber.

The testing shall proceed as follows:

- a) One or a few of the items to be tested shall be selected and subjected to free air conditions with specified test ambient temperature. After temperature stability has reached with the item(s) in loaded conditions, the temperature of representative points on the surface of the test item(s) shall be loaded.
- b) The total number of items shall then be introduced into the chamber. The chamber temperature shall be held at the temperature of the specified severity.

When items are mounted on a rack, interference with the air flow shall be as small as possible.

NOTE -If it is more convenient (for example, when introducing individual racks of identical components at different items in the same chamber) the chamber may be held, instead, at the temperature defined in (d) below.

- c) Time shall then be allowed for the chamber conditions to be re-established and for the item to reach temperature stability.
- d) The items shall be subjected to load and the chamber temperature adjusted so that, after temperature stability has been reached with the items in the loaded condition, the surface temperature of the points measured under (a) above are reproduced.
- e) Testing shall then proceed in accordance with 9.1.1.1(c) to 9.1.1.1(g).

9.2 Item with Artificial Cooling — The relevant specification shall define the characteristics of the coolant supplied to the item. When the coolant is air, care shall be taken that the air is not contaminated by oil and dry enough to avoid moisture problems.

9.2.1 Cooling System 'Isolated' from the Chamber — Items of this type have cooling systems which are either self-contained or which obtain the coolant from an extraneous supply, with the coolant flow and return lines isolated from the chamber.

IS : 9000 (Part III/Sec 4) - 1977

These items may be tested in accordance with 9.1.1.

NOTE — If cooling is so efficient that the surface temperature falls below ambient, it may be necessary to measure the ambient temperature of the surrounding air in a plane 0 cm to 5 cm above the item, half-way between the item and the wall of the chamber, rather than in a plane below the item.

9.2.2 Cooling System 'Not Isolated' from the Chamber

- a) *Items in which fresh cool air is brought from an extraneous source and then passes into the chamber after cooling of the item has taken place* — These may be tested in accordance with 9.1.1.
- b) *Items in which the cooling air is drawn from the chamber and is retimed to the chamber after fulfilling its cooling functions* — These items may be tested in accordance with 9.1.1 with the exception that monitoring shall be made on the air entering the item. The temperature of this air shall lie within the specified limits.

10. INTERMEDIATE MEASUREMENTS

10.1 The relevant specification may call for loading and/or measurements during or at the end of conditioning while the item is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be carried out. For these measurements, the item shall not be removed from the chamber.

NOTE — Measurements preceded by recovery, which would require removal and reintroduction of the item into the chamber are not permissible during the conditioning.

If it is desired to know the performance of the type of item before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

11. RECOVERY

11.1 The item shall then remain under recovery conditions for a period adequate for the attainment of temperature stability with a minimum of one hour.

11.1.1 When several items are tested simultaneously and where the *one* hour recovery period is adequate for a single item, the maximum period for recovery shall be two hours and all measurements shall be completed at the end of this period.

11.2 If required by the relevant specification, the item shall be switched on or loaded and measured continuously during the recovery period,

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11.3 If the standard conditions given above are not appropriate for the item to be tested, the relevant specification may call for other recovery conditions.

12. FINAL MEASUREMENTS

12.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

13. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

13.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

- a) Preconditioning;
- b) Initial measurements;
- c) Details of mounting or supports;
- d) State of item including cooling system during conditioning;
- e) Severity (temperature and duration of exposure);
- f) Intermediate measurements;
- g) Recovery, if non-standard;
- h) Final measurements; and
- j) Any deviation in procedure as agreed upon between the purchaser and the manufacturer.

APPENDIX A
(Clause 51.2)

VOLUME OF TEST ITEM

A-1. SIZE OF CHAMBER

A-1.0 The size of the chamber shall be such' that the conditions stated below are satisfied.

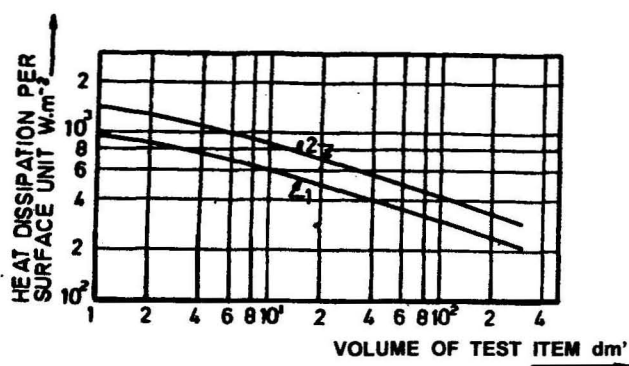
A-1.1 Volume of Item Equal to or Less Than 1 dm³

A-1.1.1 Power Dissipation Equal to or Less Than 50 W — The minimum distance between any surface of the test item and the corresponding wall of the chamber shall be not less than 10 cm.

A-1.1.2 Power Dissipation Greater Than 50 W and Equal to or Less Than 100 W — The minimum distance between any surface of the test item and the corresponding wall of the chamber shall be not less than 20 cm.

IS: 9000 (Part III/Sec 4) - 1977

A-1.2 Volume of Item Greater Than 1 dm³ — The minimum distance between any surface of the test item and the corresponding wall of the chamber shall be 10 cm unless the relationship between the volume of the test item and the power dissipation per unit of surface area is such that the curves given in Fig. 3 indicate that a greater distance is required. The ratio between the volume of the chamber and the volume of the item shall be not less than 5 : 1. The item shall as far as practical be placed close to the centre of the test chamber so as to have as much space as possible between any part of the test item and the chamber walls. The monitoring of ambient temperature is carried out in accordance with the definitions given in 2 of IS : 9000 (Part I)-1977*.



Curve 1 shows the maximum allowable heat dissipation per unit of surface area as a function of the volume of the test item when the distance between the surface of the item and the chamber is 10 cm.

Curve 2 shows the same relationship when the distance is 20 cm.

NOTE 1 -There shall be not less than 10 cm between any surface of the test item and the corresponding wall of the chamber.

NOTE 2 -The volume of the item is defined as the volume of the smallest parallelepiped in which the item may be inscribed.

NOTE 3 -The surface area of the item is defined as the total surface area of the smallest right-angled parallelepiped in which the item may be inscribed. If the heating of the item is asymmetric, the surface under consideration is only that of the side or sides most affected by the heat generation.

FIG. 3 HEAT DISSIPATION PER UNIT OF SURFACE AREA AS A FUNCTION OF THE VOLUME OF THE TEST ITEM

*Basic environmental testing procedures for electronic and electrical items : Part I General.

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART III DRY HEAT TEST

Section 5 Dry Heat Test for Heat Dissipating Items with Gradual Change of Temperature

1. SCOPE

1.1 This standard (Part III/Sec 5) deals with dry heat test for heat dissipating items with gradual change of temperature.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms given in IS : 9000 (Part III/Sec 5)-1977* shall apply.

3. OBJECT

3.1 The object of this standard 'is to provide a test procedure to determine the suitability of heat dissipating items for use under conditions of high temperature,

3.1.1 This procedure is for items which are subjected to an elevated temperature for a time long enough for the item to achieve temperature stability.

3.1.2 In this procedure, the test duration is normally measured from the time when the item achieves temperature stability. For cases where this does not apply, *see* 4.1 of Section 1.

4. GENERAL DESCRIPTION

4.1 In this test, the item while being at the ambient temperature of the laboratory is introduced into the chamber, the latter being at the temperature of the laboratory. The temperature is then gradually raised to the temperature appropriate to the degree of severity as specified in the

*Basic environmental testing procedures for electronic and electrical items: Part I General.

IS : 9000 (Part III/Sec 5) - 1977

relevant specification. After temperature stability of the test item has been reached, the item is exposed to these conditions for the specified duration. The relevant specification shall define the functioning of the item under test.

4.1.1 Care shall be taken that any cooling devices of the item are in accordance with that prescribed in the relevant specification.

4.2 The test conditions are designed to simulate the effects of subjecting the test items to 'free air' conditions with defined thermal conduction characteristics of the mounting.

4.3 The specified test temperature is defined as the ambient temperature.

4.4 Testing with no forced air circulation is the preferred method. Forced air circulation may, however, be used when it is difficult or impossible to meet the conditions specified for testing without air circulation.

5. DESCRIPTION OF TEST APPARATUS

5.1 Testing Chamber — The chamber shall conform to relevant provisions of IS : 9002 (Part II)-1977* as applicable for carrying out dry heat test on heat dissipating items with gradual change of temperature. The significant requirements are briefly described in 5.1.1 to 5.1.6.

5.1.1 The temperature in the chamber shall be checked by temperature sensing devices located so as to comply with the requirements of 2.1.2 of IS : 9000 (Part I)-1977†.

5.1.2 In the case of testing with no forced air circulation, the chamber shall be large enough compared with the size and amount of heat dissipation of the test item to allow a simulation of the effects of 'free air' conditions. The requirements on the size of chamber in which the effects of 'free air' conditions are simulated are given in Appendix A of Section 4 as a function of size and heat dissipation per surface unit of the test item.

5.1.3 The walls of the chamber shall be near to thermal black and shall have an emissivity coefficient of not less than 0.7. In order to limit radiation problems, the temperature of the walls of the chamber after temperature stability has been reached shall not differ by more than 3 percent of the specified ambient temperature for the test, expressed in K.

This requirement applies to all parts of the chamber walls and the items shall be unable to 'see' any heating or cooling elements which do not comply with this requirement.

*Specification for equipment and environmental testing for electronic and electrical items: Part II Chamber for dry heat test.

†Basic environmental testing procedures for electronic and electrical items ;Part I General,

IS : 9000 (Part III/Sec 5) - 1977

5.1.4 In the case of testing in a chamber with forced air circulation, the velocity of the air shall be as low as possible.

5.1.5 The absolute humidity shall not exceed 20 g of water vapour per cubic metre of air (corresponding approximately to 50 percent relative humidity at 35°C). When testing is performed at a temperature lower than 35°C, the relative humidity shall not exceed 50 percent.

5.1.6 Where a duty cycle is specified, precautions have to be taken if the test temperature is to be maintained at a steady figure.

In the case of components, a staggering of the on-periods will usually suffice, provided that at any one time the distribution of components on-load is reasonably uniform throughout the test chamber.

Where there is a duty cycle specified for items under test, then during the off-load periods the temperature of the chamber shall not fall below the specified test temperature (see Fig. 1 of Section 4).

5.2 Mounting

5.2.1 The thermal conduction and other relevant characteristics of the mounting and connections of the test item shall be specified in the relevant specification. When the test item is intended for use with specific mounting devices, these shall be used for testing.

5.2.2 Where the item is designed for mounting on a heat sink with unspecified characteristics, the heat sink used for the purpose of test shall possess thermal capacity and thermal conduction adequate to maintain its temperature close to the test chamber temperature.

5.2.3 Where nothing is known about the mounting characteristics, the thermal conduction of the mounting shall be low, such that for all practical purposes the item is thermally isolated.

5.2.4 In the case of component type items, it may be necessary to use mounting racks, in which case the individual specification shall give all details necessary to define the thermal characteristics of the mounting and connections. In particular, where appropriate, the specification should give the length of leads.

5.2.5 When more than one item is tested in the chamber, care shall be taken to ensure that an item is not unduly disturbed by the presence of surrounding items and mounting devices.

6. SEVERITIES

6.1 The severities, as indicated by temperature and duration of exposure, shall be specified in the relevant specification. The values shall be selected

IS : 9809 (Part III/Sec 5) - 1977

from those given below:

a) Temperature:

+ 200 \pm 2°C
+ 175 \pm 2°C
+ 155 \pm 2°C
+ 125 \pm 2°C
+ 100 \pm 2°C
+ 85 \pm 2°C
+ 70 \pm 2°C
+ 55 \pm 2°C
+ 40 \pm 2°C

NOTE 1 — The severity of 30 \pm 2°C is not considered as a dry heat severity for India. However, some equipment (for example, equipment installed in an air-conditioned atmosphere) may require conditioning and testing at a temperature lower than + 40°C and in such a case a severity of + 30°C should be chosen by the relevant specification.

NOTE 2 — In the absence of other consideration, temperatures above 200°C and up to 1000°C should be chosen from the following values:

250°C, 315°C, 400°C, 500°C, 630°C, 800°C and 1000°C.

The tolerance in each case should be \pm 2 percent of the above temperatures in °C.

NOTE 3 — Where due to the size of the chamber it is not feasible to maintain these tolerances, the tolerance may be widened to \pm 3°C up to 106°C and \pm 5°C up to 200°C. When this is done, the tolerance used shall be specified in the test report.

b) Duration:

2 hours
4 hours
16 hours
72 hours
96 hours

6.2 Where this testing procedure is used in connection with tests associated with endurance or reliability, due note shall be taken of relevant standards which give particular recommendations for durations for such tests.

6.3 If the only intention of the testing procedure is to show whether the item will function at high temperature, the conditioning may be limited to a time such that the item under test has reached temperature stability. In no case shall the duration be less than 30 minutes.

7. PRECONDITIONING

7.1 The relevant specification may call for preconditioning.

8. INITIAL MEASUREMENTS

8.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

9. CONDITIONING

9.1 Item Without Artificial Cooling

9.1.1 Testing with No Forced Air Circulation

9.1.1.1 When a single item is tested in the chamber :

- a) the chamber shall be at the temperature of the laboratory.
- b) The item, while being at the ambient temperature of the laboratory, shall be introduced into the chamber in the unpacked, switched off, 'ready for use' state, in its normal position or as otherwise specified.
- c) the temperature within the chamber shall then be gradually raised to the temperature appropriate to the degree of severity and time shall be allowed for the item to reach temperature stability.

The rate of change of temperature within the chamber shall not exceed 1°C per minute, averaged over a period of not more than five minutes.

- d) the item shall be switched on or electrically loaded and checked to ascertain whether it is capable of functioning in accordance with the relevant specification.

The item shall remain in operating condition in accordance with the duty cycle and at the loading condition (if applicable) as prescribed by the relevant specification.

- e) the item shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

The duration shall be measured from the time when temperature stability has been reached.

NOTE-In the case of small item, it is not necessary to check by measurement that temperature stability has been reached [see Note under 2.1.2 of IS : 9000 (Part I)- 1977*].

- f) if required by the relevant specification, intermediate measurements shall be performed in accordance with **10**.

*Basic environmental testing procedures for electronic and electrical items : Part I General,

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- g) at the end of this period, the item shall remain in the chamber and the temperature shall be gradually lowered to a value lying within the limits of standard atmospheric conditions for testing. The rate of change of the temperature within the chamber shall not exceed 1°C per minute, averaged over a period of not more than 5 minutes.

In case the item remains in operating or loaded conditions during the test, it shall be switched off or unloaded before the temperature is lowered.

- h) at the end of this period the item shall be subjected to the recovery procedure in the chamber or otherwise as appropriate.

9.1.1.2 When more than one item is tested in the chamber- When more than one item is tested in the same chamber, it is required that the surface temperature measured at corresponding points on the test items shall not deviate from one item to another by more than 5 deg C or 5 percent of the difference between the surface temperature and the air (ambient) temperature, whichever is the greater (see Note 2).

NOTE 1 -A check that this requirement is met shall normally be made with the items mounted in the chamber in the manner used for testing. If it is impracticable to make this check inside the chamber, the check may be made outside the chamber under normal laboratory conditions. The items shall be mounted in the manner used for testing (for example, on a rack) and care shall be taken that the items are not subjected to extraneous disturbing influences.

NOTE 2 -The requirement on acceptable deviation between surface temperature at corresponding points on the test items is intended to limit the effects of stacking of item on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 percent, whichever is greater) shall not include the deviations caused by differences in heat dissipation between individual items. Such differences may be taken care of by checking on the same individual item in different positions in the chamber.

Testing shall proceed in accordance with 9.1.1.1.

9.1.2 Testing with Forced Air Circulation

9.1.2.1 When a single item is tested in the chamber- Either Method A or Method B described below, where forced air circulation is allowed, may be used when it is not possible to meet the conditions specified for testing without air circulation. The air velocity shall be low (if possible, not more than 0.5 m/s).

- a) **Method A** — This method is intended to be used when the chamber used for testing is large enough to meet the conditions specified in Appendix A of Section 4 but maintenance of the ambient temperature in the chamber may only be obtained by circulation of air.

The item is placed, or assembled inside the test chamber. With both the chamber air flow and heat switched off, the item shall be subjected to the loading conditions specified for the elevated temperature at which the test is to be carried out.

When temperature stability of the item has been reached, the temperatures of a number of representative points shall be measured using a suitable monitoring device. The temperature rise which occurs at each point shall then be noted.

The chamber air flow is switched on and, once temperature stability has been achieved, the temperature of the representative points shall again be measured. If the temperatures differ from those measured without air flow by more than 5 deg C or any other value stated by the relevant specification, the velocity of the air is too high and shall be reduced until the requirement of 5 deg C or other specified temperature difference is met. If this is not possible, Method B shall be used.

The chamber heating is now switched on for the commencement of testing. The monitoring of ambient temperature shall be carried out in accordance with the definition in 2.1.2 of IS : 9000 (Part I)-1977*.

Testing shall then proceed in accordance with 9.1.1.1

A diagrammatic representation of Method A is given in Fig. 1.

- b) *Method B*— This method is intended to be used when the requirements in Appendix A of Section 4 cannot be met.

It is based on the assumption that the difference, ΔT_1 , between the temperature of a hot point on the test item and the ambient temperature of the surrounding air in free air conditions is more or less independent of the ambient temperature of the surrounding air. This applies only if ΔT_1 is less than 25 deg C where the ambient temperature variation, ΔT_2 , does not exceed 30 deg C.

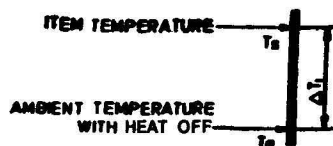
These ranges may be extended to 80 deg C and 65 deg C respectively if the corrections described in Fig. 2 of Section 4 are applied.

It shall be noted that the corrections cover convection errors as well as radiation errors.

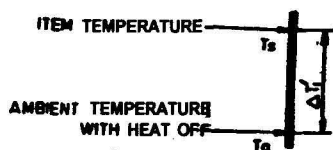
For temperature difference, ΔT_1 , greater than 80 deg C and/or changes in ambient temperature, ΔT_2 , greater than 65 deg C, the validity of Method B has not been verified.

*Basic environmental testing procedures for electronic and electrical items : Part I General.

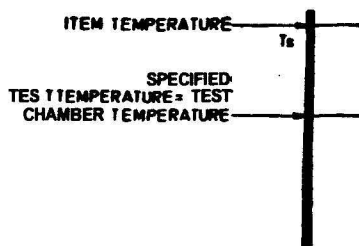
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Stage 1 — Item loaded. Test in chamber conditions with chamber airflow off and heat off. Measurement of item temperature.



Stage 2 — Item loaded. Test in chamber conditions with chamber airflow on and heat off. $\Delta T_1 - \Delta T'_1$ shall be small.



Stage 3 — Item loaded. Test in chamber conditions with chamber airflow on and heat on. Monitoring on specified ambient test temperature.

FIG. 1 DIAGRAMMATIC REPRESENTATION OF TEST WITH FORCED AIR CIRCULATION FOR METHOD A

The item suitably mounted in the laboratory and protected from disturbing influences, such as sunlight and draughts, shall be subjected at room ambient temperature to the loading conditions specified for the elevated temperature at which the test is to be carried out.

When temperature stability has been reached, the temperature of the hottest point or, in the case of larger or more complicated items, the temperature of a number of representative points shall

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be measured. The temperature rise, ΔT_1 , which occurs at each point, shall be noted.

The item is introduced into the test chamber, subjected to the specified loading, and the chamber temperature is adjusted to a value at which the points measured at room ambient temperature reach a stabilized value which is the algebraic sum of the ambient temperature specified for the test and ΔT_1 . If ΔT_1 is less than 25 deg C, testing shall proceed in accordance with 9.1.1.

If ΔT_1 is greater than 25 deg C, the corrected temperature, T_2 , based on the specified test temperature, shall be determined as described in Fig. 2 of Section 4. The item shall be introduced into the chamber while both item and chamber are at room temperature. Then the item shall be switched on or electrically loaded as prescribed in the relevant specification and the chamber temperature raised.

The rate of change of temperature shall not exceed 1 deg C per minute averaged over a period of not more than 5 minutes.

The final value of the chamber temperature shall be adjusted to a value at which the point measured on the surface of the item at room ambient temperature reaches the 'above-mentioned' stabilized value T_2 . This temperature shall be maintained throughout the conditioning. Testing shall then proceed in accordance with 9.1.1.1(d) to 9.1.1.1-(h). A diagrammatic representation of Method B is given in Fig. 1 of Section 4.

9.1.2.2 When more than one item is tested in the chamber — When more than one item is tested in the same chamber, it is required that the surface temperatures measured at corresponding points on the test items shall not deviate from one item to another by more than 5 deg C or 5 percent of the difference between the surface temperature and the air (ambient) temperature whichever is greater (see Note 2).

NOTE 1 - A check that this requirement is met shall normally be made with the items mounted in the chamber in the manner used for testing, with the chamber heater switched off but the air circulation switched on.

NOTE 2 - The requirement on acceptable deviation between surface temperature at corresponding points on test items is intended to limit the effects of stacking of items on the temperature gradient in the test chamber. The tolerance of the temperature difference given (5 deg C or 5 percent, whichever is greater) shall not include the deviations caused by differences in heat dissipation between individual items. Such differences may be taken care of by checking on the same individual item in different positions in the chamber.

The testing shall proceed as follows:

- a) One or a few of the items to be tested shall be selected and subjected to free air conditions with the specified test ambient temperature. After temperature stability has been reached with

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the item(s) in loaded conditions, the temperature of representative points on the surface of the test item(s) shall be noted.

- b) The total number of items shall then be introduced into the chamber. The air circulation and heat of the chamber shall be switched on and the temperature shall be adjusted so that, after temperature stability has been reached with the items in loaded conditions, the surface temperatures at the points measured under (a) are reproduced.

When items are mounted on a rack, interference with the air flow shall be as small as possible.

Testing shall then proceed in accordance with 9.1.1.1.

9.2 Item with Artificial Cooling — The relevant specification shall define the characteristics of the coolant supplied to the item. When the coolant is air, care shall be taken that the air is not contaminated by oil and dry enough to avoid moisture problems.

9.2.1 Cooling System 'Isolated' from the Chamber— Items of this type have cooling systems which are either self-contained or which obtain the coolant from an extraneous supply, with the coolant flow and return lines isolated from the chamber:

These items may be tested in accordance with 9.1.1, with Method A of 9.1.2.1 as an alternative.

NOTE—If cooling is so efficient that the surface temperature falls below ambient, it may be necessary to measure the ambient temperature of the surrounding air in a plane 0 cm to 5 cm above the item, half-way between the item and the wall of the chamber, rather than in a plane below the item.

9.2.2 Cooling System 'Not Isolated' from the Chamber

- a) *Items in which fresh cool air is brought from an extraneous source and then passes into the chamber after cooling of the item has taken place* — These may be tested in accordance with 9.1.1, with Method A of 9.1.2.1 as an alternative.
- b) *Items in which the cooling air is drawn from the chamber and is returned to the chamber after fulfilling its cooling function* — These may be tested in accordance with 9.1.1, with Method A of 9.1.2.1 as an alternative, with the exception that monitoring shall be made on the air entering the item. The temperature of this air shall lie within the specified limits.

10. INTERMEDIATE MEASUREMENTS

10.1 The relevant specification may call for loading and/or measurements during or at the end of conditioning while the item is still in the chamber. If such measurements are required, the relevant specification shall define the measurements and the period or periods after which they shall be

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carried out. For these measurements, the item shall not be removed from the chamber.

NOTE--Measurements preceded by recovery, which would require removal and reintroduction of the items into the chamber, are not permissible during the conditioning.

If it is desired to know the performance of the type of item before the end of the prescribed duration, one additional lot will be required for each specified duration. Recovery and final measurements shall be performed separately for each lot.

11. RECOVERY

11.1 The item shall then remain under standard recovery conditions for a period adequate for the attainment of temperature stability, with a minimum of one hour.

11.1.1 When several items are tested simultaneously and where the one hour recovery period is adequate for a single item, the maximum period for recovery shall be two hours and all measurements shall be completed at the end of this period.

11.2 If required by the relevant specification, the item shall be switched on or loaded and measured continuously during the recovery period.

11.3 If the standard conditions given above are not appropriate for the item to be tested, the relevant specification may call for other recovery conditions.

12. FINAL MEASUREMENTS

12.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

13. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

13.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

- a) Preconditioning;
- b) Initial measurements;
- c) Details of mounting or supports;
- d) State of item including cooling system during conditioning;
- e) Severity (temperature and duration of exposure);
- f) Measurements and/or loading during conditioning;
- g) Recovery, if non-standard;
- h) Final measurements; and
- j) Any deviation in procedure as agreed upon between the purchaser and the manufacturer.

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